THE SOUTHERN CALIFORNIA FOREST BAT FORAGING HABITAT SURVEY OF 1997

Prepared by:
Diana Simons
P.O. Box 461031
Los Angeles, CA 90046

Prepared for:
U.S. Department of Agriculture, Forest Service
Pacific Southwest Region and Cleveland National Forest
10845 Rancho Bernardo Road, Suite 200, San Diego, CA 92127

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Introduction

Southern California is a diverse landscape. Within a few miles can be found a wide variety of habitat types and associated organisms. Bats are a part of this diversity, with 24 species occurring in California. Eleven of these species were captured during the 1997 forest bat foraging habitat survey.

The purpose of the bat foraging habitat survey was to improve our understanding of the distribution, abundance, and habitat relationships of southern California bat species. Data was collected for use with GIS applications to construct models for evaluating land use and management practices and for devising habitat conservation strategies.

The two year field study began in the1996 summer season. Mist netting was conducted at 32 sites throughout the U.S. Forest Service southern California province. The study area encompassed the Los Padres, Angeles, San Bernardino and Cleveland National Forests. A special focus of the mist netting activities the first year was to find reliable capture sites for 3 target species (*Myotis evotis, M. thysanodes* and *M. volans*) to be used in a radio-telemetry study (Miner, Brown 1996). Mist netting was continued the second summer, 1997, but no radio-telemetry was conducted.

An additional component of the survey in 1997 was the collection of auditory data using the *Anabat II* bat detector (Titley Electronics, Ballina, N.S.W., Australia). The *Anabat* hardware and software system allows for field identification of free-flying bats through analysis of their ultrasonic echolocation calls.

Survey results from 1996 were included in the report of the radio-telemetry study (Miner, Brown 1996) and will not be recapitulated here. This report will cover the mist netting activities of 1997.

A total of 38 sites were visited one or more times in 1997. Because of the broad geographical range that had to be covered during the summer field season there was not enough time to do in depth work in specific areas. Only three of the sites were visited two or more times. Thus the work done was not comprehensive in nature, but serves as a preliminary survey of bat species distributions and habitat relationships. Many Forest Service districts previously had no bat records at all and thus a baseline has been provided for cumulative future study. Information gathered in this survey will be useful for conservation and management of species and habitats.

Table 1. Bat species caught in 1997 Foraging Habitat Study

Family Vespertilionidae:

Species	legal status (as of 11/96)	#caught	F / M / Unknown
Antrozous pallidus Pallid bat	*	7	4 / 2 / 1
Corynorhinus townsendii Townsend's Big-eared bat	F2, *	2	0 / 2
Eptesicus fuscus Big Brown bat		163	23 / 125 / 15
Lasiurus cinereus Hoary bat		2	0 / 2
Myotis californicus California myotis		37	21 / 14 / 2
Myotis ciliolabrum Western small-footed myotis	F2	11	4 / 7
Myotis evotis Long-eared myotis	F2	50	24 / 26
Myotis thysanodes Fringed myotis	F2, **	5	2 / 3
Myotis volans Long-legged myotis	F2, **	16	14 / 2
Myotis yumanensis Yuma myotis	F2	18	15 / 3
Pipistrellus hesperus Western pipistrelle		19	12 / 7
Total bats caught		331	

Legal Status: F2 = USFWS Category 2 Candidate

* = CA Dept. of Fish & Game Species of Special Concern

** = Included on 1996 preliminary list of revised Mammal Species of Special Concern

Table 2. MIST NETTING LOCATIONS FOR 1997

(200#'s are new for 1997, 100#'s are repeated sites from 1996)

Forest	Site # and Name	Elev	District	Date
Los Padres				
	201) Branch Creek Road Crossing	1160'	Santa Lucia	7/21
	202) Salinas River Road Crossing	1400'	Santa Lucia	7/22
	203) Cachuma Creek	2080'	Santa Barbara	7/9
	204) Fox Creek/ Santa Ynez River	1900'	Santa Barbara	7/10
	205) Indian Creek at Bluff Camp	4400'	Santa Barbara	7/28
	206) Lower Santa Cruz Creek	1960'	Santa Barbara	7/29
	207) Frazier Mountain Lookout	7775'	Mt. Pinos	8/13
	208) Painted Rock Cattle Trough	4400'	Mt. Pinos	8/4
	106) Pine Spring Cattle Trough	5700'	Mt. Pinos	8/20
	209) Chief Peak Pond	4750'	Ojai	7/23
Angeles				
	210) San Francisquito Adit Release	1520'	Saugus	6/25
	211) Baal Point	1680'	Saugus	9/9
	110) Little Rock Station	3200'	Valyermo	6/5
	212) Dorr Canyon Spring	7680'	Valyermo	6/30, 9/2
	213) Big Rock Campground	5720'	Valyermo	7/14, 8/26,10/30
	214) Islip Saddle/ Snow Spring	6120'	Arroyo Seco	8/5
	215) Buckhorn Campground	6600'	Arroyo Seco	7/1
	111) Alder Creek	3520'	Arroyo Seco	7/2
	113) West Fork San Gabriel River	1749'	Mt. Baldy	7/16
San Bernardino				
	216) Alpine Canyon	6700'	Cajon	7/15
	117) Arrastre Creek	6440'	Big Bear	8/18
	217) Belleville Meadow	7400'	Big Bear	6/23, 7/15, 8/5
	121) Holcomb Creek/Beaver Ponds	6600'	Big Bear	6/18
	218) Bear Creek/ Santa Ana River	3600'	San Gorgonio	8/12
	119) Sugarloaf Meadow	6769'	San Gorgonio	8/21
	219) Coon Creek	7200'	San Gorgonio	5/27
	220) Deep Creek	5880'	Arrowhead	8/25
	124) Miller Canyon Road Crossing	3800'	Silverwood State Pk.	8/19
	125) Miller Canyon Culvert	3600'	Silverwood State Pk.	8/19
	126) May Valley Cattle Trough	5120'	San Jacinto	6/17
	221) Quinn Flat Cattle Trough	4200'	San Jacinto	6/23
	222) Herkey Creek	4960'	San Jacinto	6/24
	223) Black Mountain	7280'	San Jacinto	8/11
Cleveland				
	132) Filaree Flat	5320'	Descanso	5/9
	133) Laguna Ranch	5480'	Descanso	7/17
	134) Laguna Meadow	5440'	Descanso	7/24
	135) 79 Bridge at Sweetwater River	4000'	Cuyamaca State Pk.	7/31
	224) Lower Doane Valley	4522'	Palomar	8/16
	225) Lucky Chuck Mine Area	4160'	Descanso (Anabat only)	

HABITATS

The vegetation categories used here originated from the U.S. Forest Service GIS database, however sites were assigned to the vegetation types on the basis of field observations of the plant communities surrounding the netting sites rather than by using the GIS pre-mapped computerized information.

Because mist netting for bats most often takes place over water there was a riparian element to most of the sites. However, if the riparian zone was small (eg. a creek) compared with a much larger surrounding vegetation type then the dominant plants of the broader general area were used to describe the site. This was because the study was attempting to establish species/habitat relationships in which foraging and roosting behaviors would be important components. Where a large river dominated the landscape the site was designated as riparian.

An attempt was made to strike a balance between over-specificity in grouping plant types and over-generalization of the data in order to fit it into broad categories. This posed a problem in some cases because sample sizes were quite small and subdivisions diminished them even further. Ecotones were only used for sites in which it was felt that important variables of the habitat/species relationship would otherwise be lost. Plant community transition zones can be a factor in local species diversity and thus valuable to record.

See Table 4 for bat species caught in each habitat.

Coniferous Forests (CNF)

The 11 sites in this category ranged in elevation from 4960' to 7775'. The highest location, #207 Frazier Mountain Lookout, was in a pure Jeffrey pine (*Pinus jeffreyi)* stand and the lowest coniferous forest site, #222 Herkey Creek, contained Jeffrey and Ponderosa (*Pinus ponderosa)* pines and Coulter pines *(Pinus coulteri)* with a mixed chaparral understory.

Sites #212-215 were in mixed conifer (Ponderosa and Jeffrey pines, Incense cedar *(Calocedrus decurrens)* and White fir *(Abies concolor)*) with Sugar pine *(Pinus lambertiana)*.

Some intermediate elevation coniferous sites, such as #121 Holcomb Creek at 6600', also contained Black oak *(Quercus kelloggii)*.

Oak Woodland (OAK)

The 6 oak woodland sites ranged from 1400' to 5120'. Site #202 Salinas Crossing was an oak savannah consisting of Blue *(Quercus douglasii)*, Valley *(Q. lobata)* and Coast live *(Q. agrifolia)* oaks with grassland patches in between.

Sites #203 Cachuma Creek and #204 Fox Creek/Santa Ynez River were situated in Southern Coast Live Oak Riparian forest (Holland 1986). They were placed in the oak woodland category because the oaks were the dominant vegetative feature. Site #204 was a wide wash in a canyon with chaparral beginning 200 yards up slope.

Other oak woodland sites contained Canyon live oak *(Q, chrysolepis)* as well as Coast live oak. Black oak did not predominate at any sites but was associated with some conifer communities.

Pinyon Juniper Woodland (PJW)

One site, #117 Arrastre Creek, was in Pinyon juniper woodland at 6440', featuring Western juniper *(Juniperus occidentalis)* and Single-leaf pinyon pine *(Pinus monophylla)*.

Site #106 Pine Spring Cattle Trough was in a transition zone between Pinyon juniper woodland and Jeffery pine forest. Because both vegetation types were clearly and evenly featured at this site it was treated as an ecotone (CNF/PJW).

Chaparral (CHP)

All but one of the chaparral sites were in Chamise chaparral (Holland, 1986). This plant community includes chamise *(Adenostoma fasciculatum)*, manzanita *(Arctostaphylos glauca)*, California Buckwheat (*Eriogonum fasciculatum), Ceanothus spp.* and Whipple yucca *(Yucca whipplei*).

Site #211 Baal Point was a night roost in an abandoned building of a former recreation area where exotics had been planted. Some chaparral plants, mediterranean annual grasses and weeds had moved into the area.

Grassland/ Meadows (GRM)

Three of the four grassland/meadow sites were being used for cattle grazing and the water sources netted were cattle troughs. These sites were #208 Painted Rock, #221 Quinn Flat and #134 Laguna Meadow. The fourth site, #119 Sugarlaof Meadow, had

been used for grazing in the past although the practice had been discontinued there for several years. The trough at Painted Rock had the longest distance to the nearest trees (>one mile) which may have been a contributing factor to the lack of captures there.

Both sites combining coniferous forest and grassland/meadow (CNF/GRM) were in the Cleveland National Forest and were surrounded by pine/oak woodland.

Riparian (RIP)

Riparian sites were situated at rivers that were large enough to dominate the landscape and surrounding vegetation. Site #113 West Fork San Gabriel River was lined with a corridor of White Alder Riparian forest (Holland, 1986) consisting of White Alder *(Alnus rhombifolia)* with a shrubby, deciduous understory in a steep sided canyon. The riparian vegetation at #135 Sweetwater River was willow *(Salix sp.)* and California wild rose *(Rosa californica)*.

Sagebrush Scrub (SBS)

Site #110 Little Rock Station differs from the rest in that it was not a foraging area, but a day roost for a maternity colony of Yuma myotis *(Myotis yumanensis)*. The structure was the overflow tunnel for Little Rock reservoir, located only 1/4 mile away. The local vegetation contained chamise and sage species *(Artemisia spp.)*.

Ecotones

Seven sites were designated as ecotones that could not be easily generalized into single categories. These were placed in separate categories that reflected the blend of vegetation types in the area. For example, site #201 at Branch Creek Road Crossing, was a canyon with a small creek riparian zone that divided Blue oak woodland (Holland, 1986) on the north facing slope and Chamise chaparral (Holland, 1986) on the south facing slope. Because each of these vegetation types stretched for a considerable distance in either direction the site was designated as an ecotone (OAK/CHP).

Site #218 Bear Creek/Santa Ana River was treated as an ecotone because chaparral vegetation was traversed by a river, over 30' wide in places, with associated riparian plants.

METHODS

Mist netting sites were over water sources within the forests, with the exception of two day roosts. Types of water used were pooled areas in creeks, lightly flowing creeks, ponds and pooled areas in rivers (see Table 3).

Table 3. MIST NETTING SITE TYPES

	Totals	Flowing creek	Pooled creek	River	Pond	Trough	Roosts
Hours over each site type	104.75	27.5	35.75	11.75	5.25	20.5	4
Antrozous pallidus	7	1	4			1	1
Pallid bat	0.07	0.04	0.11			0.05	0.25
Corynorhinus townsendii	2	1		1			
Townsend's big-eared bat	0.02	0.04		0.09			
Eptesicus fuscus	163	4	145	1	3	10	
Big Brown bat	1.56	0.15	4.06	0.09	0.38	0.49	
Lasiurus cinereus	2		1	1			
Hoary bat	0.02		0.03	0.09			
Myotis californicus	37	8	19			10	
California myotis	0.35	0.29	0.53			0.49	
Myotis ciliolabrum	11		6			5	
Western small-footed myotis	0.11		0.17			0.24	
Myotis evotis	50		39			11	
Long-eared myotis	0.48		1.09			0.54	
Myotis thysanodes	5		3			2	
Fringed myotis	0.05		0.08			0.1	
Myotis volans	16		16				
Long-legged myotis	0.15		0.45				
Myotis yumanensis	18		1	5			12
Yuma myotis	0.17		0.03	0.43			3
Pipistrellus hesperus	20	5	13	2			
Western pipistrelle	0.19	0.18	0.36	0.17			
Total bats caught	331	19	247	10	3	39	13
Bats per hour	3.16	0.69	6.91	0.85	0.57	1.9	3.25

The upper numbers are totals for bats caught; the lower numbers are the averaged bats captured per hour.

Table 4. BAT SPECIES PER HOUR BY VEGETATION TYPES

	Totals	Elev L/H	CNF	OAK	PJW	CHP	GRM	RIP	SBS *	CNF/PJW	CHP/RIP	CNF/OAK	CNF/GRM	OAK/CHP
Hours in vegetation type	104.75		42.25	12.75	2.5	12.5	9.5	5.5	2	3.5	2.5	4	4.5	3.25
# of sites each veg type	38		11	6	1	6	4	2	1	1	1	2	2	1
Antrozous pallidus	7	1160'-6600'	4			1				1				1
Pallid bat/ bats per hour			0.09			0.08				0.29				0.31
Corynorhinus townsendii	2	6440'			1			1						
Townsend's big-eared bat					0.4			0.18						
Eptesicus fuscus	163	1160'-7775'	133	7	2		3	13			3			2
Big Brown bat/ bats per hour			3.15	0.55	0.8		0.32	2.36			1.2			0.62
Lasiurus cinereus	2	5720'	1					1						
Hoary bat/ bats per hour			0.02					0.18						
Myotis californicus	37	1160'-7775'	15	4	7	1	1	2					5	2
California myotis			0.36	0.31	2.8	0.08	0.11	0.36					1.11	0.62
Myotis ciliolabrum	11	5720'-7775'	4		2		1	1		2			1	
Western small-footed myotis			0.09		0.8		0.11	0.18		0.57			0.22	
Myotis evotis	50	5700'-7680	39							7		2	2	
Long-eared myotis			0.92							2		0.5	0.44	
Myotis thysanodes	5	6600'-7775'	4		1									
Fringed myotis/ bats per hour			0.09		0.4									
Myotis volans	16	5720'-7680'	16											
Long-legged myotis			0.38											
Myotis yumanensis	18	1680'-1749'				2		5	10		1			
Yuma myotis/ bats per hour						0.16		0.91	5		0.4			
Pipistrellus hesperus	20	1900'-6700'	8	2	6	3					1			
Western pipistrelle			0.19	0.16	2.4	0.24					0.4			
Total Bats Caught	331		224	13	19	7	10	5	23	10	5	2	8	5
Bats per hour	3.16		5.3	1.02	7.6	0.56	1.05	0.91	*11.5	2.86	2	0.5	1.78	1.54

CNF=coniferous forest, OAK=oak woodland, PJW=pinyon juniper woodland, CHP=chaparral, GRM=grassland/meadows, RIP=riparian, SBS=sagebrush scrub,*=roost site

Captured bats were identified as to species, sex and reproductive status, weighed and measured (forearm, ear and foot), then released.

An effort was made to have each Forest Service district represented in the survey. To achieve this end some sites were used that were less than optimal if they were the only choices for nettable water on the district. For example, on the Ojai district of the Los Padres N.F., #209 Chief Peak Pond was used because two other sites that had appeared promising earlier in the summer were dry by the date of the field nights in the area. This cattle pond was a third choice because it was devoid of vegetation that would create a flyway for the bats to funnel into, and too deep to wade into successfully.

A harp trap was used in conjunction with mist netting at #117 Arrastre Creek in the San Bernardino N.F. Interestingly enough, only one bat was caught in the trap that night, and it was one of only two Townsend's big-eared bats *(Corynorhinus townsendii)* that were caught during the summer of 1997.

RESULTS

In the course of this survey equal hours were not spent in all vegetation types. To normalize for this the number of bats caught per site was divided by the number of total hours spent in that type of vegetation. This gives a view of the relative abundance of species caught at different vegetation types without the bias of the longer hours spent in some locations (see Table 4). The same approach was taken in evaluating types of water sources netted; the number of bats caught at a given type of water source was divided by the total number of hours spent netting over that kind of water (Table 3).

Pooled areas in creeks afforded the most reliable capture sites, especially where creeks crossed dirt roads. This created an ideal combination of still water, a flyway cleared of vegetation with a natural funnel effect to facilitate catching the bats.

Higher elevations yielded more individuals captured per hour and higher species diversity. Most capture diversity occurred in coniferous forest, with 9 of the 11 species caught during the summer coming from there. Pinyon juniper and riparian areas came in second with 6 species each. Ecotones raised the bats-per-hour count significantly for Pallid bats, California myotis and Western small-footed myotis. As expected, capture rates for Yuma myotis were highest over riparian areas.

The appearance in the data of Yuma myotis bats as being particularly abundant in sagebrush scrub may be deceptive. This species specializes in foraging over open water and often roosts in buildings, bridges and mines (Barbour & Davis, 1969). Because these

bats were caught emerging from a cement tunnel (their day roost), which was 1/4 mile from a reservoir (their foraging habitat), it is not clear to what extent the bats associated with the local sagebrush scrub vegetation.

Big Brown bats *(Eptesicus fuscus)* and California myotis *(Myotis californicus)*, the generalists, were caught over the widest range of elevations (1160'-7775') and the broadest array of vegetation types, while specialists like Long legged-myotis *(Myotis volans)* were only found in coniferous forest above 5700'. Western pipistrelles *(Pipistrellus hesperus)* used an assortment of vegetation types, but all below 6700'. The Fringed myotis *(Myotis thysanodes)* had the narrowest elevational range of any species (a band only 1175 feet wide between 6600' and 7775' elevations), and a very low capture rate per hour. The Long-eared myotis *(Myotis evotis)*, another high elevation species, had a slightly wider range than the Fringed myotis but an extremely high capture rate per hour in coniferous forest.

For sheer numbers Big Brown bats were way out in front with 163 individuals caught during the summer. The next runners-up were Long-eared myotis with 50 and California myotis with 37 individuals caught. Townsend's big-eared bats and Hoary bats *(Lasiurus cinereus)* had the lowest capture rates of only 2 each.

Big Brown bats caught were overwhelmingly males at the sites surveyed (totals for the summer were 125 males and only 23 females (see Table 1). At #213 Big Rock Campground an interesting sex ratio emerged. 24 males and 0 females were caught early in the summer and when the site was revisited at summer's end only 7 males and 2 females were caught.

Over all, the lowest netting success occurred in chaparral vegetation. These areas usually had less water to net over, but this still could have manifested in high capture rates if all bats in the area had to make use of only a few available water sources. Because catches remained low it appeared that there were not many bats in some of these locations.

While on the whole cattle troughs were very successful as netting sites (sometimes these were the only available water in the area), their success depended in part on proximity to the nearest trees. For example, site #208 Painted Rock, a trough surrounded by miles of pastureland meadow, did not yield any captures. Bats did not cross the open grassland area to get to this trough.

Data collected on phases of the moon did not yield any clear trends.

DISCUSSION

Some of the promising sites from 1996 were not available in 1997. These would still make potentially good netting spots in the future. Some examples are #109 Fish Canyon, which was ravaged by fire in the fall of 1996, and #108 Chismahoo Cattle Trough which had good bat activity in chaparral vegetation in 1996 but was dry in 1997. Site #107 Blue Point was a river at which Western Mastiff bats *(Eumops perotis)* were clearly audible and visible. This stretch of river appears quite similar to a location in Big Bend, Texas where Mastiff bats and other Mollosids were caught (Higginbotham, 1997), and more work could be done there.

It is of particular interest that no Mollosid species were captured in 1996 or 1997. Four species from this family are present in southern California: the Western Mastiff bat, the Mexican free-tailed bat *(Tadarida brasiliensis)*, the Pocketed free-tailed bat *(Nyctinomops femorosaccus)* and the Big free-tailed bat *(Nyctinomops macrotis)*. Different mist netting strategies from those used thus far will be necessary to catch these bats.

Approaches for future survey site selection could take different forms. One method would be to establish consistent point count stations that would be monitored at regular intervals to track bat use during different seasons and from year to year. Another approach might be to continue looking for new foraging habitat locations suitable for mist netting in an attempt to fill gaps in the data for vegetation types and for species that have not yet been adequately represented. Many sample sizes in this survey were too small to support confident conclusions, and thus are useful only as pointers to areas where more data is needed. Possible goals for more focus might be ecotones, non-water netting sites or vegetation such as Pinyon juniper woodland, where not enough time was spent. Still another survey approach might be to narrow down the geographical area to be covered and select target zones to be visited several times (or at least more than once) during the summer field season. Because the southern California province of the National Forest is such a large area to cover it was impossible in this survey to have multiple field nights at all the sites in the time allotted.

A highlight of the 1997 survey was to find such strong evidence of Long-eared myotis, Long-legged myotis and Fringed myotis, the target species of the year before, which had been so elusive outside of the Cleveland National Forest in 1996.

CONCLUSION

The importance of this survey was to document what bat species are present in southern California forests and what foraging habitats they associate with. The ultimate significance of this baseline data will be in how it will be encorporated into management plans and conservation strategies involving bats.

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